Building a Statewide Address Location Database

Current Status, Issues, Plans

MassGIS / Wareham, MA
February 4, 2013

Information Technology Division
Executive Office for Administration and Finance

Workshop agenda

In partnership with State 911, we are creating a statewide map of address locations

This map will be more detailed and more complete than any currently available map

In this workshop, we'll describe:

- **Current and future 911 use of GIS**
- **The need for standards and a statewide approach**
- **What's been produced so far**
- **What we will complete this year**
- **What will remain to be done**

Workshop agenda

We want to hear from you as well:

- **Are you trying to solve the same problem at the local level?**
- **What can we learn from your efforts and experience?**
- **How are you currently managing address data?**

Most important, we want to engage you in this effort:

- **We are already working with many cities and towns**
- **A GIS-based address database is a resource for municipalities**
  - public safety, permitting, notifications, schools etc.
- **The first version will require field work to complete**
- **We will need local involvement as well to maintain it**

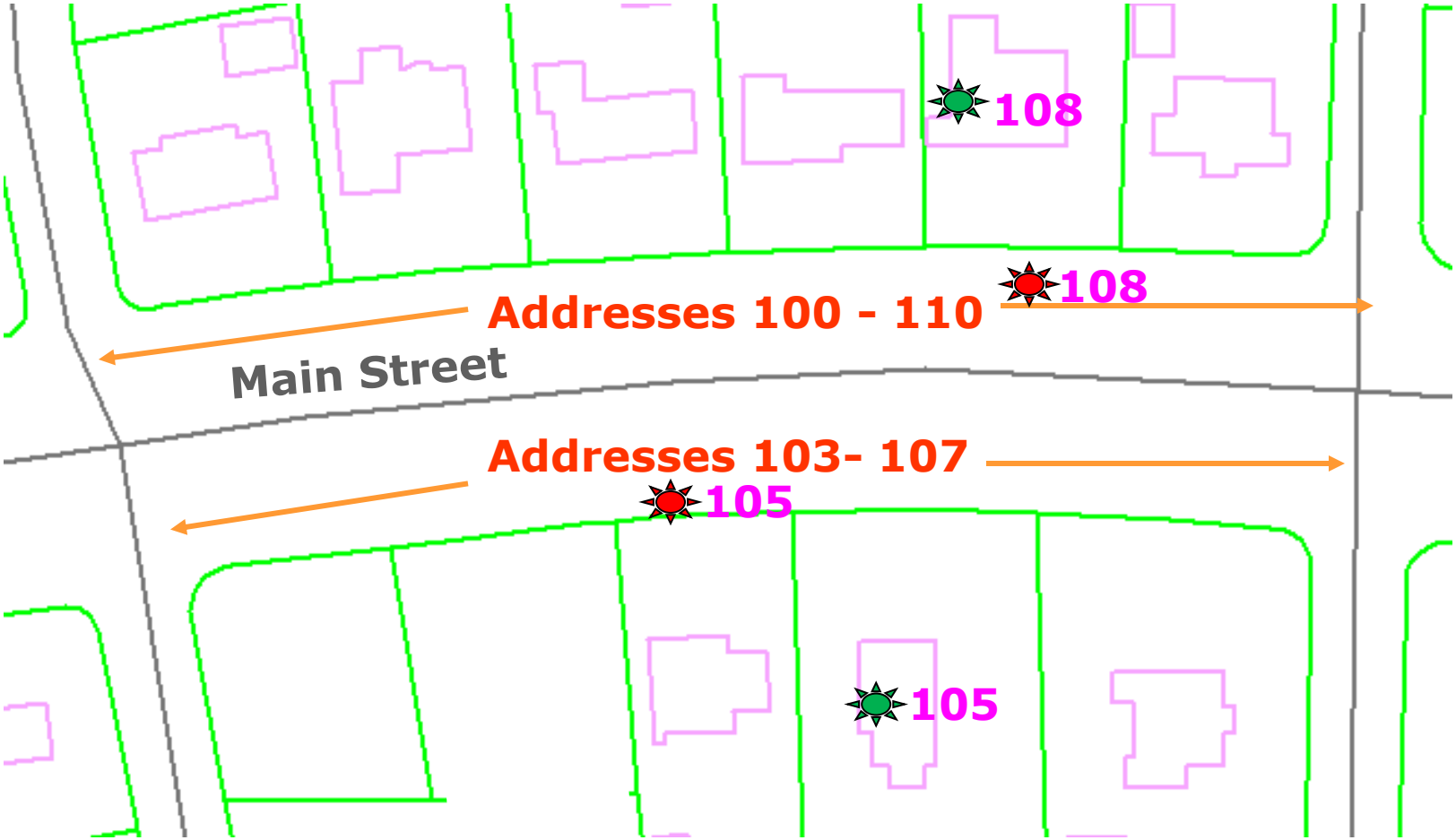
Current Technology

GIS and 911 requirements – current technology

- **Some 911 terminology**
  - PSAP = Public Safety Answering Point
    a 911 call is routed to a PSAP where a dispatcher manages the response
  - NG-9-1-1 = Next Generation 911
    standards and specifications for modernized 911 which will be GIS-driven, IP-based, and support multiple protocols
  - ESN, ESZ = Emergency Service Number, Emergency Service Zone
    unique combination of PSAP and police, fire, medical responders
    the ESZ is the area for a single ESN
  - MSAG = Master Street Address Guide
    list which assigns an ESN to every valid, contiguous ranges for every street in a community
  - ESL = Emergency Service List
    complete list of land line numbers, new addresses validated against MSAG
- **Current technology – display caller location**
  - Linear geocoding is used to plot addresses coming in with the call
  - Reverse geocoding used to show address nearest cell call

Geocoding, point and linear

Geocoding is deriving a map location (lat-long or x,y) from a street address, for example: 105 Main Street or 108 Main Street



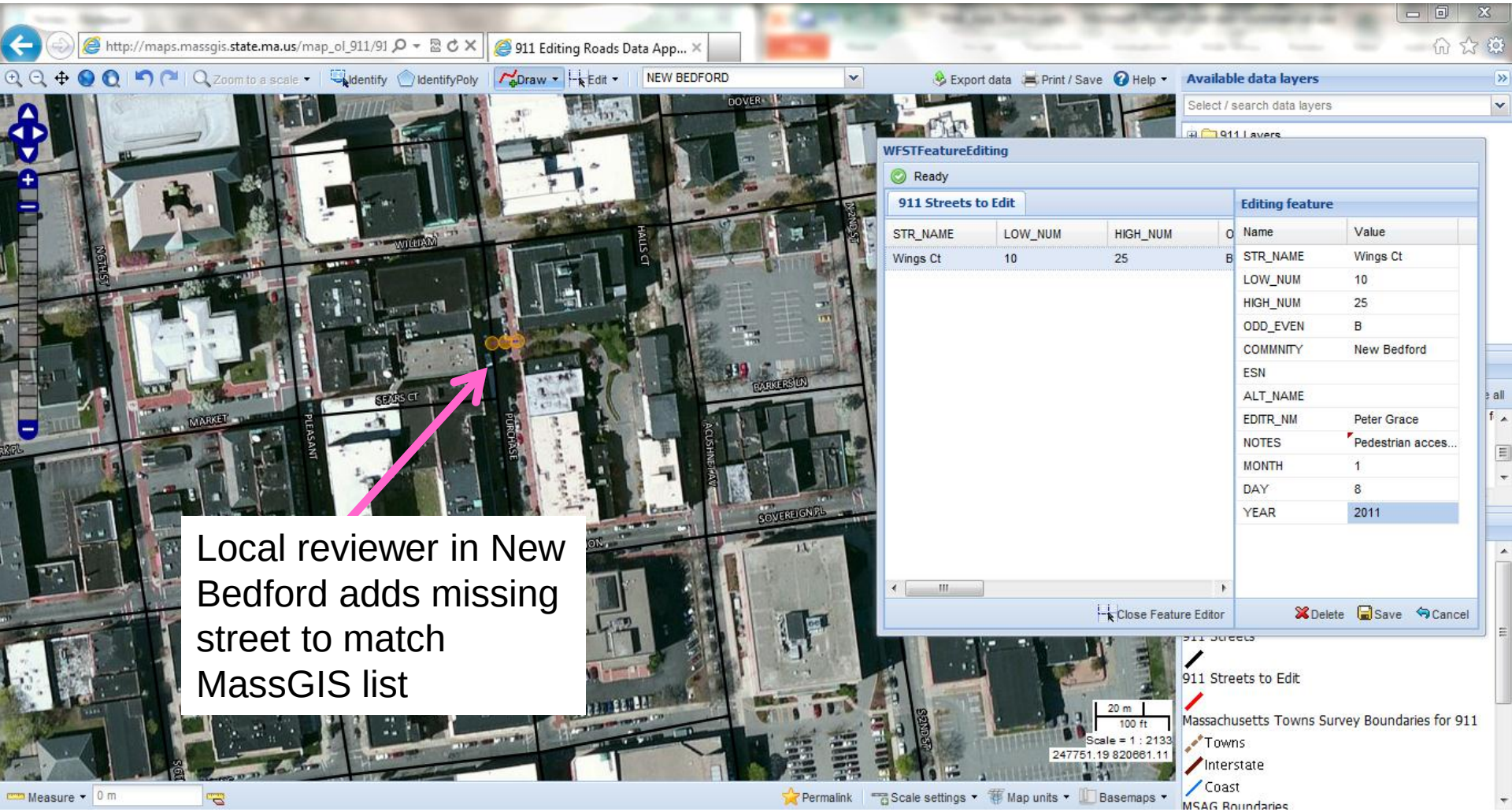
Current technology - Mapstar in PSAP

Shown is an address plot is Mapstar. This software runs in all PSAPs but many use Computer Aided Dispatch systems as well.

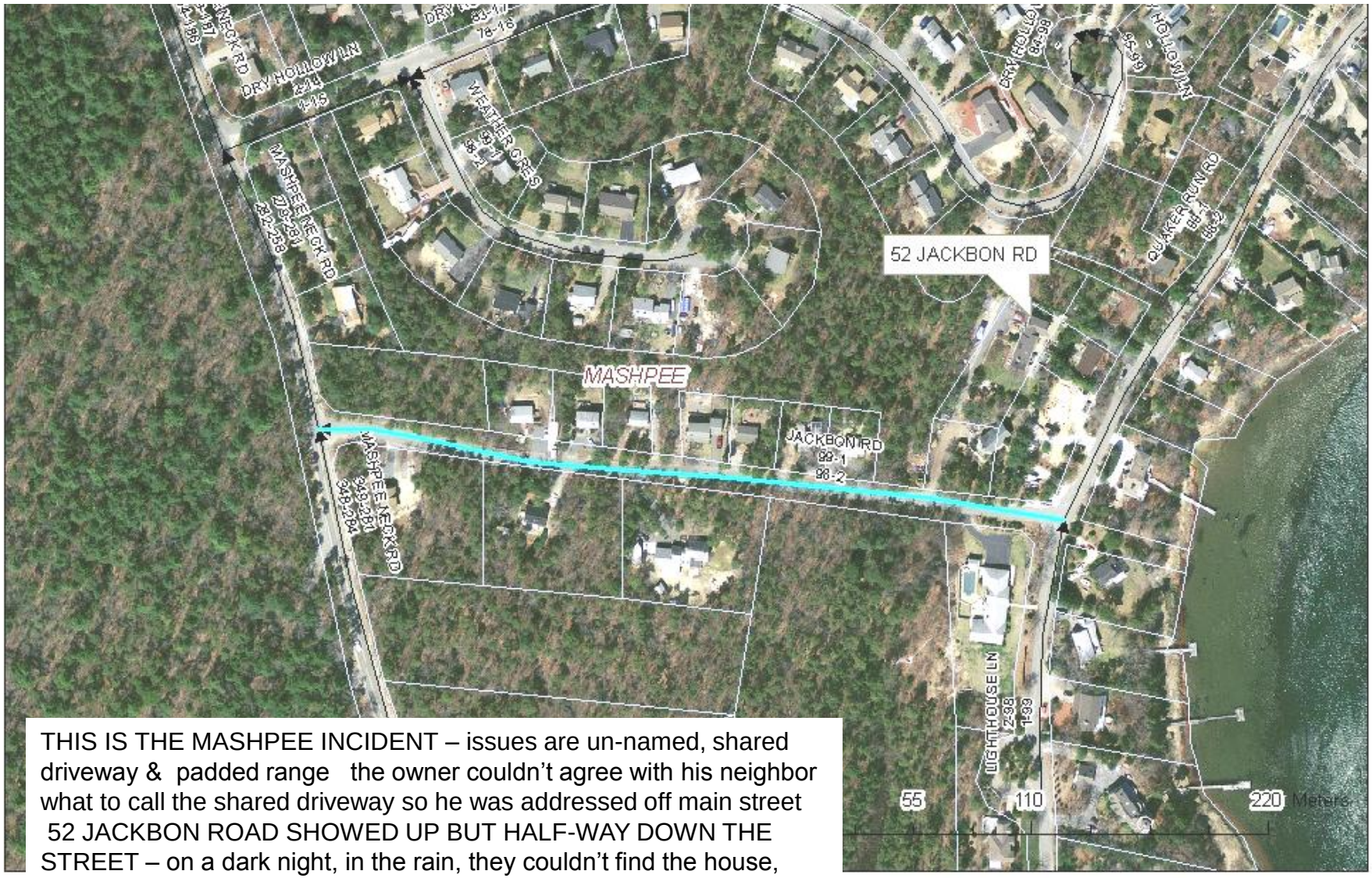
Current technology - linear geocoding

- **We provide street map for PSAPs to geocode**
  - based on product from NAVTEQ, commercial provider
  - edited extensively by MassGIS to work with Mapstar
- **We task NAVTEQ to capture missing and new streets**
  - quarterly submission of Map Requests to collect new streets and ranges with GPS-enabled vehicles
- **Since the project inception, the street map has dramatically improved**
  - 45,000 edits, 4,000 new streets
  - currently about 100-200 requests / quarter
- **Geocoding hit rates: match to MSAG**
  - September 2007 - 87% of street segments
  - October 2012 – about 99.5% (99.8% ESL)
  - 3000+ developed streets not in MSAG

Current technology - local input to street map



Current technology - why we need point addressing



THIS IS THE MASHPEE INCIDENT – issues are un-named, shared driveway & padded range the owner couldn't agree with his neighbor what to call the shared driveway so he was addressed off main street 52 JACKBON ROAD SHOWED UP BUT HALF-WAY DOWN THE STREET – on a dark night, in the rain, they couldn't find the house,

Current technology – shared driveways

Future Technology
Next Generation 911

Future technology - Next Generation 911

- **National Emergency Numbering Association (NENA) is developing standard for next generation of 911 technology**

- **NG-9-1-1 will use caller locations (GIS points) and emergency service zones (GIS polygons) to route calls and assist dispatch..**
- **for routing:**
  - caller location comes from GPS in cell phone or from matching address from landline
  - emergency service zones identify PSAP
  - point-in-polygon overlay is used to assign the call
- **for response:**
  - caller location is displayed with other map layers to assist in dispatch

Future technology – design considerations

To support call routing and enhanced dispatch in NG, we need:

- ***a location for <u>all</u> addresses***
- ***a map of emergency service zones***

<u>Design Considerations in Massachusetts</u>

1. Parcel data represent the most obvious initial source for address location
2. Parcel data can be aggregated to represent emergency service zones
3. Multiple sources of address information must be conflated
4. Best to represent address locations by visible features such as buildings
5. Assignment of addresses should minimize interpretation
6. Many addresses may be associated with one location
7. Many-to-many relationships difficult to manage; use multi-points
8. Sites like campuses, large condo complexes need more address detail

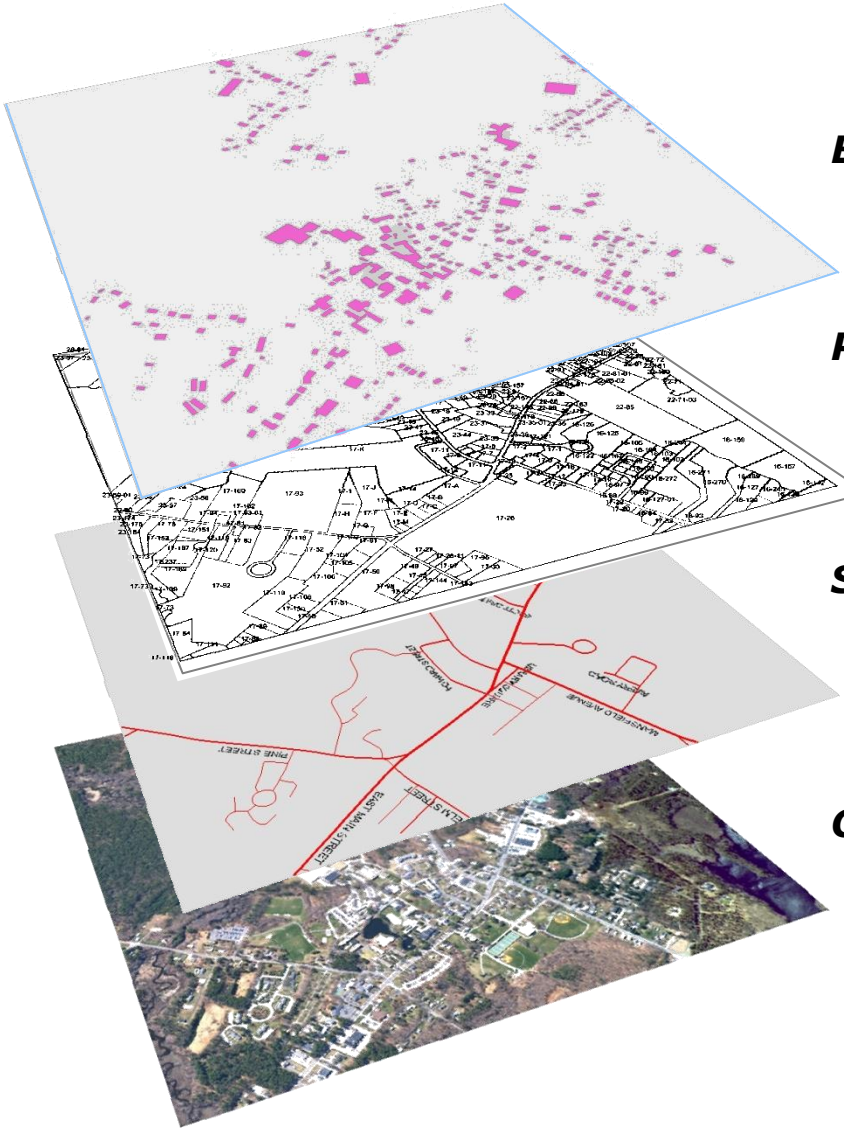
Future technology – data requirements

- updated imagery
- updated street map with ranges
- standardized tax parcels
- outlines of all structures

plus…

- standardized addresses from various sources
- emergency service zones

Future technology – Massachusetts Spatial Data Infrastructure (MSDI)



Buildings

- Accurately mapped using imagery
- Linked via overlay to parcels

Parcels

- Boundaries linked to tax records
- Created on ortho and road base

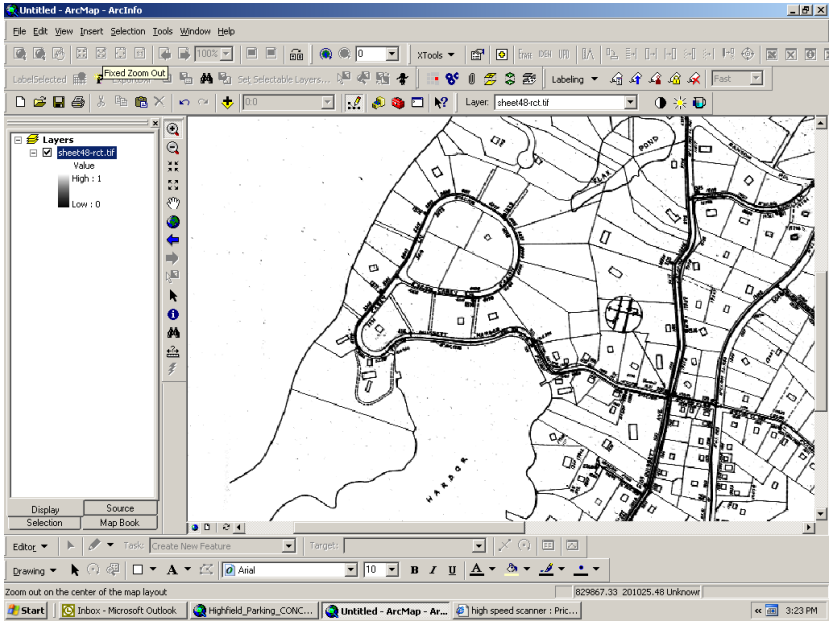
Streets

- Created on ortho base
- Ranges support linear geocoding

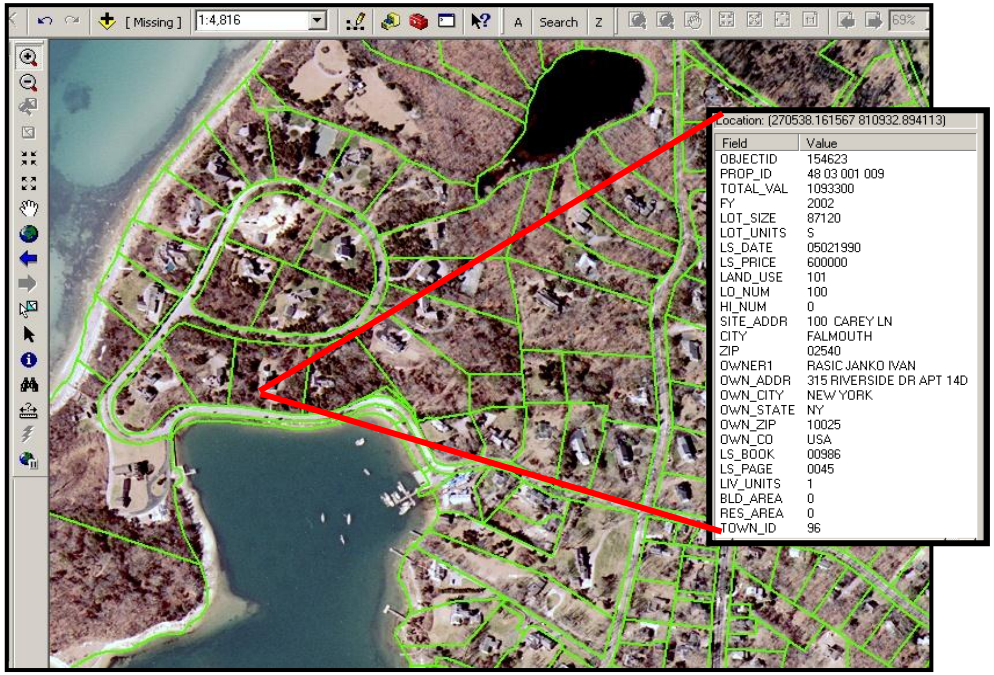
Orthophoto & LiDAR

- Orthorectified aerial imagery is accurate, intuitive base for all other GIS data development
- LiDAR provides additional info & QA

Parcel data – initial address locations



local tax maps are brought into GIS and matched to aerial photo, assigned a unique statewide ID and linked to the tax records at 99.5% match



tax records provide site address, owner name, use code, building value and year built

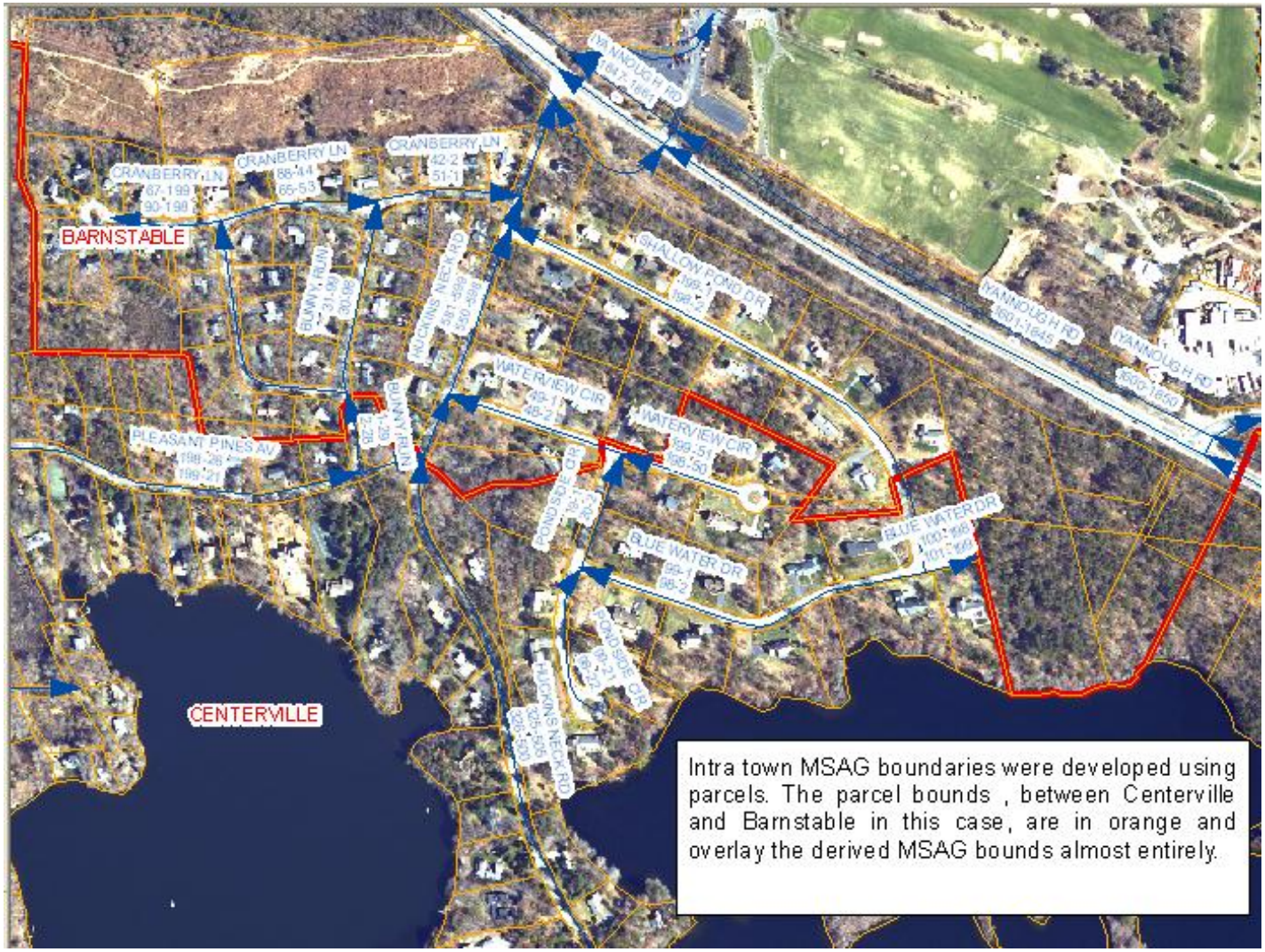
3 year - $3M project to standardize about 2.2. million parcels; funded primarily by IT bond. Substantial economies of scale compared to individual jurisdictions, 3x or more.

Parcel data –updates to local GIS data

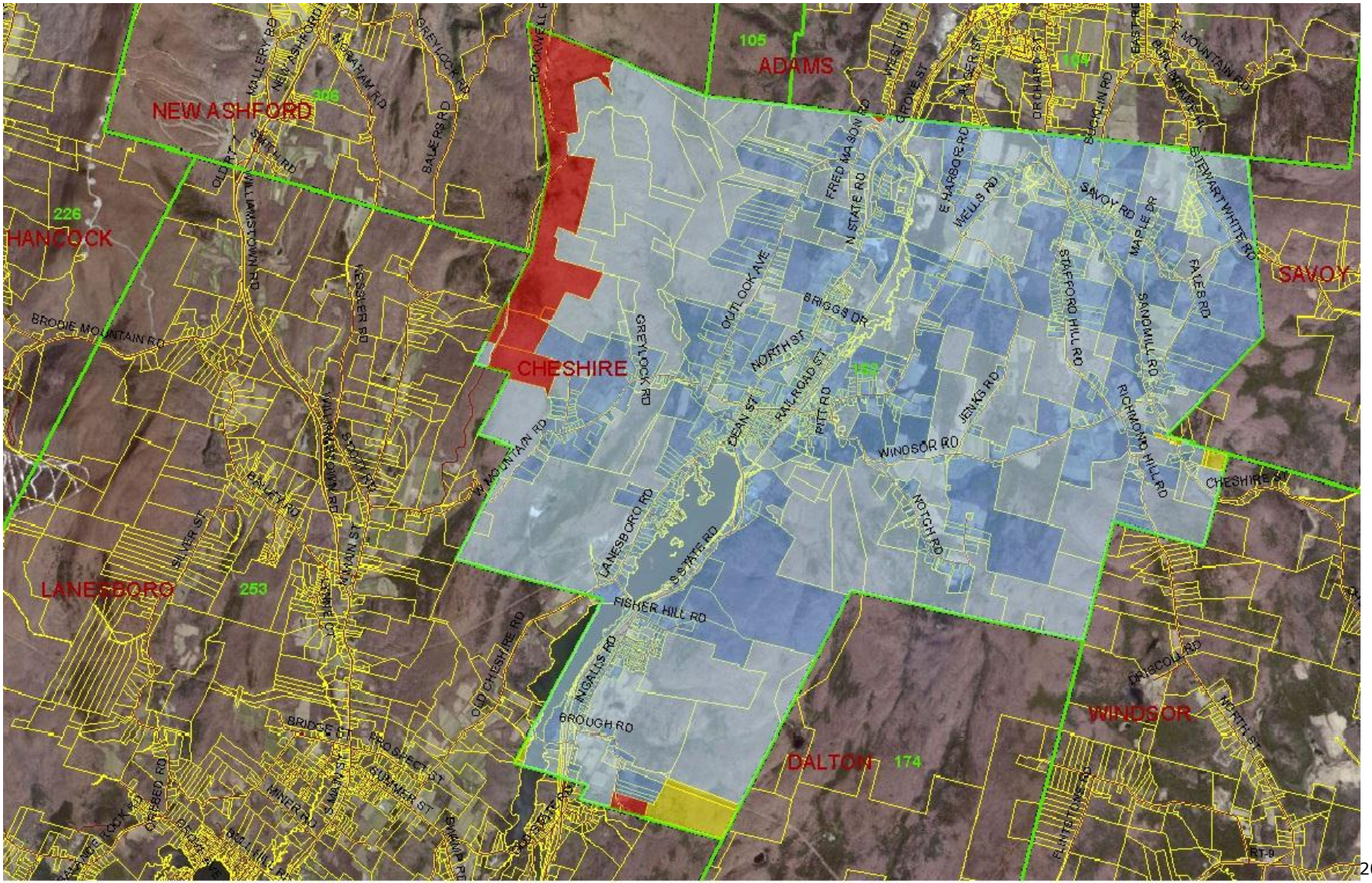
accurate registration of parcels and orthos makes transfer of address info to structure mapping possible

Parcel data - mapping Emergency Service Zones

Emergency Service Zones defined by parcel boundaries to match MSAG listing of ESNs – this allows for geocoding any incoming caller location to correct PSAP



Parcel data –review of Emergency Service Zones



Parcel data - ESN boundary issues

This is a close-up of one situation on the boundary between Dracut (on the left) and Methuen. McGrath Road is in the MSAG for Dracut but not Methuen. The red is an unassigned parcel, meaning we can't determine assignment from MSAG and blue is assigned to the other community. Blue parcel at the bottom is on "North Lowell Street" in Methuen but egress is to Dracut so that has to be reviewed

Structures – complete statewide.

Structure outlines were completed statewide at a cost of about $0.13 per outline for about 2.4 million structures

The centers of these building outlines, which we can automatically generate in the GIS, provide the initial set of points to be linked to the parcel address.

These data are now available on our web-site..

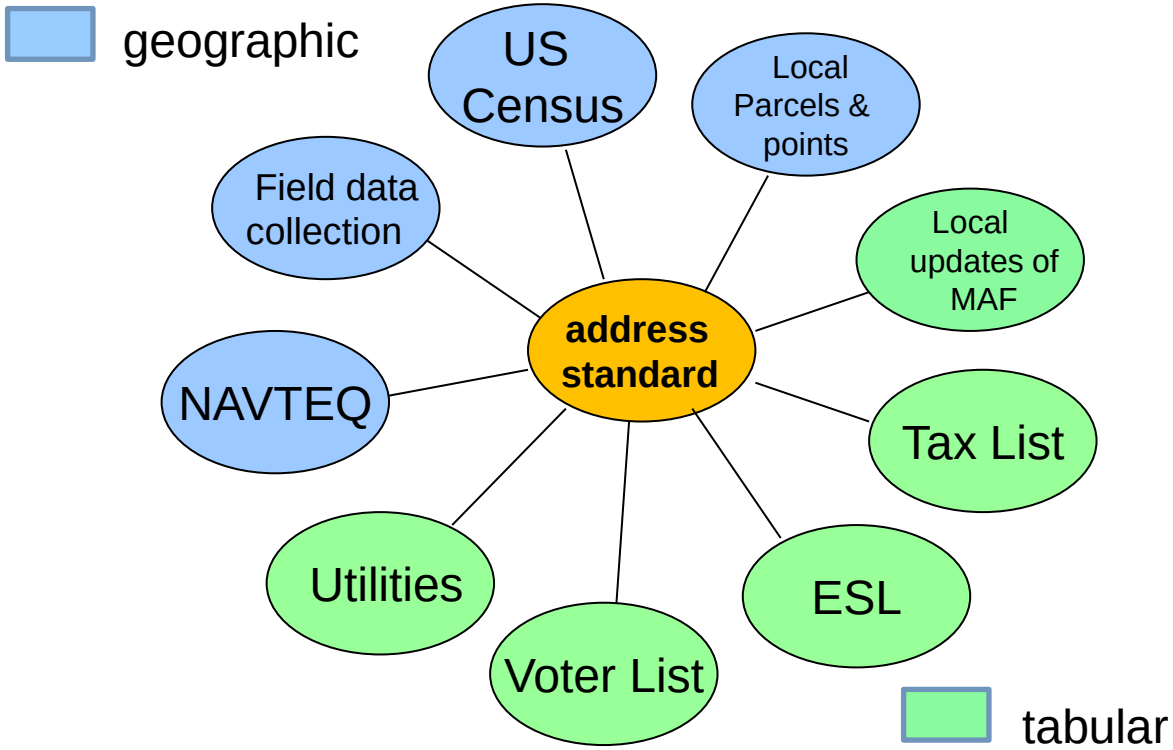
Address data - what is an address anyway?

- **Thoroughfare address = number, street, location**
  - parts of an address must be distinct
  - location also called sub-address includes any info NOT part of number or street name like unit, building name, etc.
  - 20 | Main Street | Unit 4

- **Functions of an address**
  - how you physically find a location
  - how you uniquely identify something
  - how you send mail to person or business
- **Address locations can be more or less accurate**
  - unit within bldg.
  - entrance to a bldg. with signage (this could be a separate unit) ← *Sweet spot for public safety*
  - a building itself ← *this may be perfectly adequate*
  - identifier for parcel of land ← *or even this*
  - entrance to campus with multiple bldgs.
  - estimated location using linear geocode ← *what we have now*

Address data - why is a standard so important?

- **A standard allows for automated matching between many different address lists & mapping sources**
  - **Emergency Service List is no longer complete list**
  - **Each candidate address needs to be matched against existing list**
  - ***Geocoding must be exact, not fuzzy match***

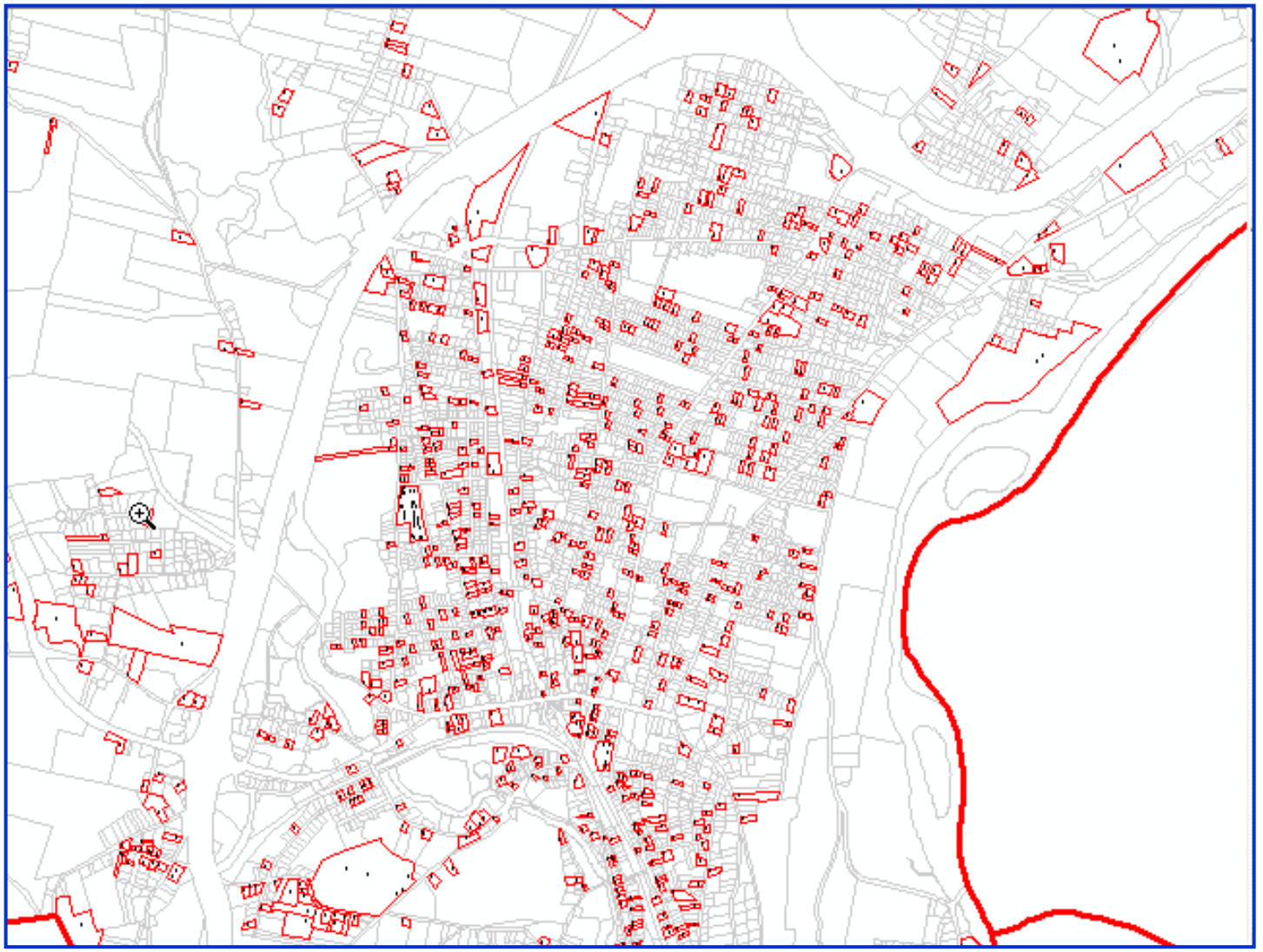


Address data – ESL isn't complete.

This map of a portion of Greenfield MA shows developed parcels with no land-line

Currently, 23% of households have cell phones only and 37% don't answer their land-line.

As a result, the ESL is no longer a comprehensive source of addresses.



Address data standard from NENA and FGDC

Cleaning up and standardizing address information is a major challenge but NENA requires it. We first parse addresses into three parts – number, street and location (sub-address), then further parse those into the fields below.

Address Number – Prefix, Number, Suffix

- prefix "**B**18", "**Milepost** 12.2"
- number "**247**"
- suffix "12**A**", "14 **½**"
- ranges are stored in two number fields to allow for inequality testing

Each part of a street name has to conform to the specification from NENA with allowable values for street type and so on validated against a reference list.

Street Name – standard says everything fully spelled out

- pre-mod "**Old** North Coach Road", "**Upper** Hampden Road"
- pre-dir "**South** Main Street"
- pre-type "**Avenue** A"
- street-name "**Broadway**"
- post-type "Market **Street**"
- post-dir "Washington Street **South**"
- post-mod "Charles Street **Place**", "Chatham Street **Extension**"

Address data - Master Street Table based on standard

SOURCETYPE	FULL_STR	FULL_STR_STD
TIGER	**Garden Street Ct**	**GARDEN STREET COURT**
BASE_STREETS	**GARDEN ST CT**	**GARDEN STREET COURT**
NAVTEQ	**GARDEN STREET CT**	**GARDEN STREET COURT**
MSAG	**GARDEN ST CT**	**GARDEN STREET COURT**
WARREN_GROUP	**Garden Street Court**	**GARDEN STREET COURT**
MSAG	**E Spring St RR Xng**	**EAST SPRING STREET RAILROAD CROSSING**

MassGIS has completed a lookup of the street name in a number of statewide sources (TIGER, Warren Group, MSAG, DOT, NAVTEQ) to a standardized version. Discrepancies in type or spelling have been reconciled as well as expanding all abbreviations to conform to NENA standard.

Address data – sub-address

The ESL, tax lists, utility customer lists, voter lists and other sources of address information will frequently include unit information. Also common are site names (landmark addressing) and in the ESL at least identification of specific buildings or even floors. This information must be standardized as well before address lists can be compared.

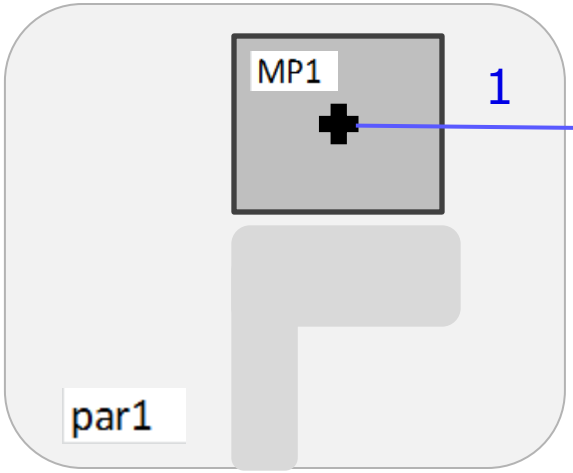
Sub-address (ESL "location", postal "secondary location")

- site "**Bristol Community College**, Administration Building"
- subsite "Jackson Athletic Complex, **Field C**"
- building "Mission Hill Condos, **Building A**", "**Admissions Building**, UMASS"
- rel_loc "47 Market Street, **left side**" "22 Maple Drive**, rear**"
- floor "**2**nd Floor, Program Office"
- unit "Unit **7A**"
- own_occ "**Dunkin Donuts**", "**Mariott Hotel**" (also called landmark name)

Address location data management

- **Every address links to just one location**
- **An address location can be:**
  - **parcel centroid (pre-assigned address)**
  - **non-building point such as playing field or parking lot**
  - **cluster of building center points (multi-part point)**
  - **building center point**
  - **building entry**
  - **building interior**
- ***Every address location must be geographically distinct and must convey "real" information about that location relative to other locations***
  - **no stacked points**
  - **no "shotgun" or arbitrarily placed points**
- **An single address location is often linked to more than one address**
- **Center of building cluster can be used for labeling**

Simplest case –
one parcel, one structure, one address



1

LOC_ID	ADDRPT_ID	FULL_ADDR
par1	MP1	1 CAMDEN WAY

MP1 = 1 address multi-point
par1 = parcel LOC_ID

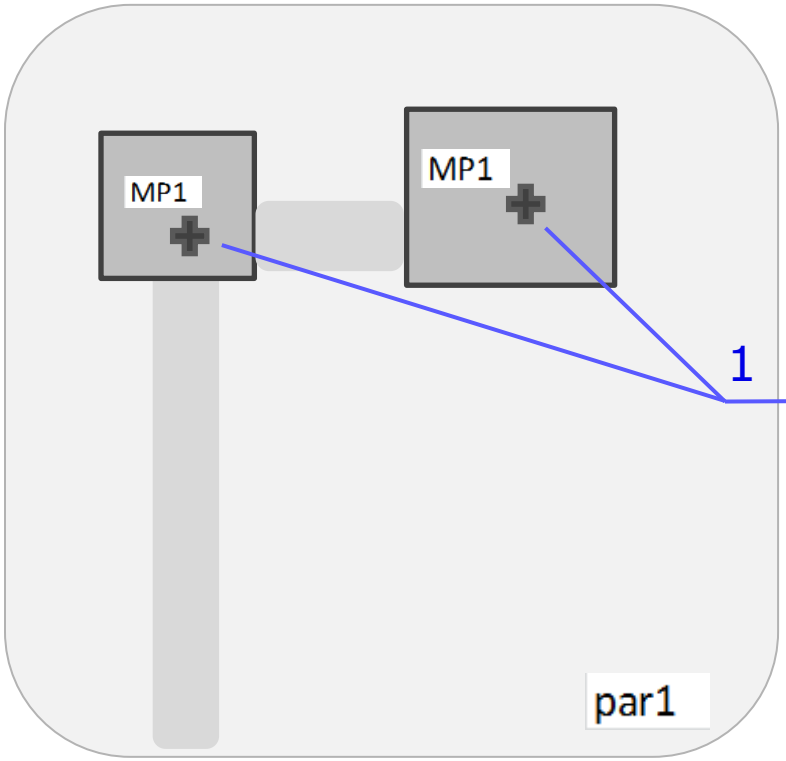
In the simplest case, we transfer the parcel address to the address point created as the centroid of the building.

Master Address Database examples

One ESL record doesn't match – field work is needed to find it. Utility and voter lists can be useful to validate such cases as well.

SOURCETYPE *	FULL_NUM *	FULL_STR *
WG	90	Blueberry Ln
L3	90	BLUEBERRY LN
ESL	94	BLUEBERRY LN
WG	94	Blueberry Ln
L3	94	BLUEBERRY LN
ESL	97	BLUEBERRY LN
WG	97	Blueberry Ln
ESL	100	BLUEBERRY LN
WG	106	Blueberry Ln
L3	106	BLUEBERRY LN
ESL	107	BLUEBERRY LN
WG	107	Blueberry Ln
L3	107	BLUEBERRY LN
ESL	114	BLUEBERRY LN

Most common case – several structures, one address (not a "site")



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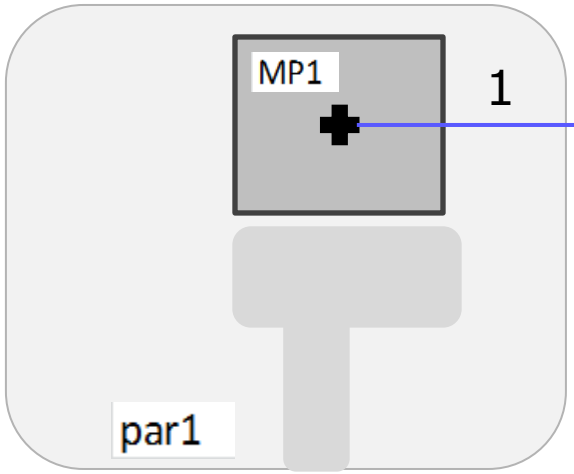
LOC_ID	ADDRPT_ID	FULL_ADDR
par1	MP1	1 CAMDEN WAY

MP1 = 1 address multi-point
par1 = parcel LOC_ID

In aerial view, these structures on a residential lot could be a house, a barn, a garage, an in-law apartment. For public safety purposes , we can't assume we know which is the "primary" structure or which ones have land-lines.

Also very common –
One building with many units

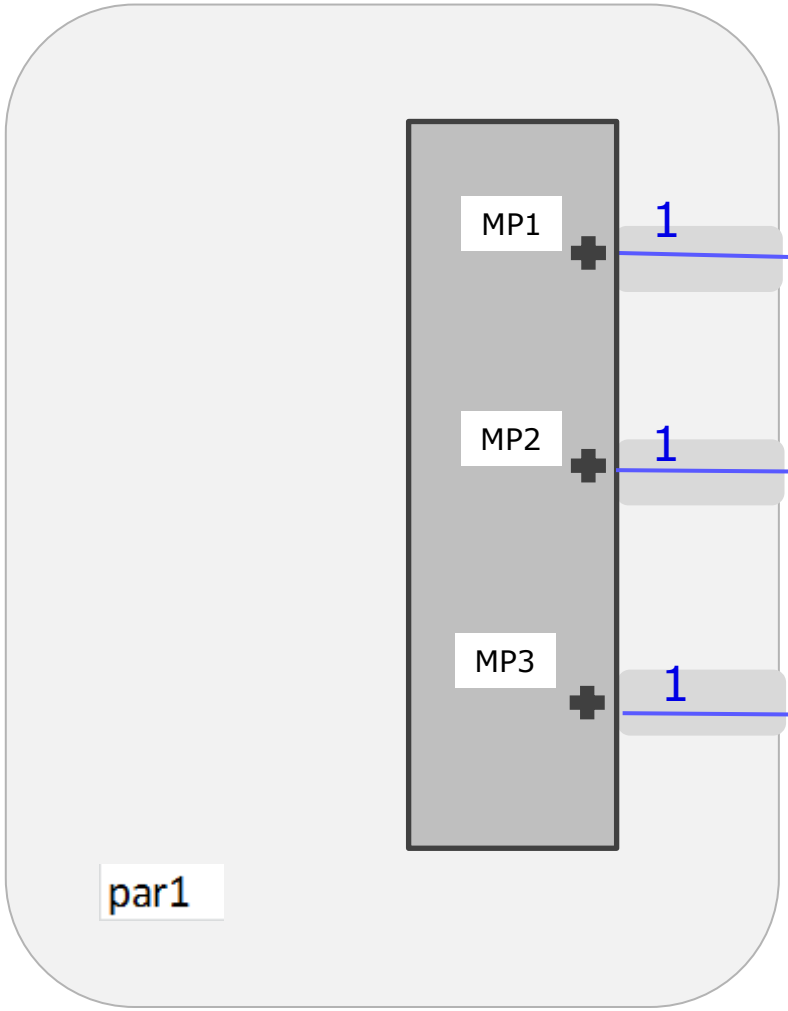


LOC_ID	ADDRPT_ID	FULL_ADDR
par1	MP1	104 NORTON AVENUE #10
par1	MP1	104 NORTON AVENUE #11
par1	MP1	104 NORTON AVENUE #12
par1	MP1	104 NORTON AVENUE #13
par1	MP1	104 NORTON AVENUE #14
par1	MP1	104 NORTON AVENUE #15
par1	MP1	104 NORTON AVENUE #16
par1	MP1	104 NORTON AVENUE #17
par1	MP1	104 NORTON AVENUE #18
par1	MP1	104 NORTON AVENUE #19

For this apartment building, a single address point is linked to multiple addresses, rather than being represented by "stacked" points. This relational approach makes editing and data management, especially in more complex cases covered later, much easier.

Higher geographic precision – one building, three entries, four numbered addresses

Here there are multiple addresses for a single structure. The address points must represent "real" entry locations rather than being arbitrarily placed.



1

LOC_ID	ADDRPT_ID	FULL_ADDR
par1	MP1	1 CAMDEN WAY

1

LOC_ID	ADDRPT_ID	FULL_ADDR
par1	MP2	3 CAMDEN WAY

M

LOC_ID	ADDRPT_ID	FULL_ADDR
par1	MP3	5 CAMDEN WAY
par1	MP3	5A CAMDEN WAY

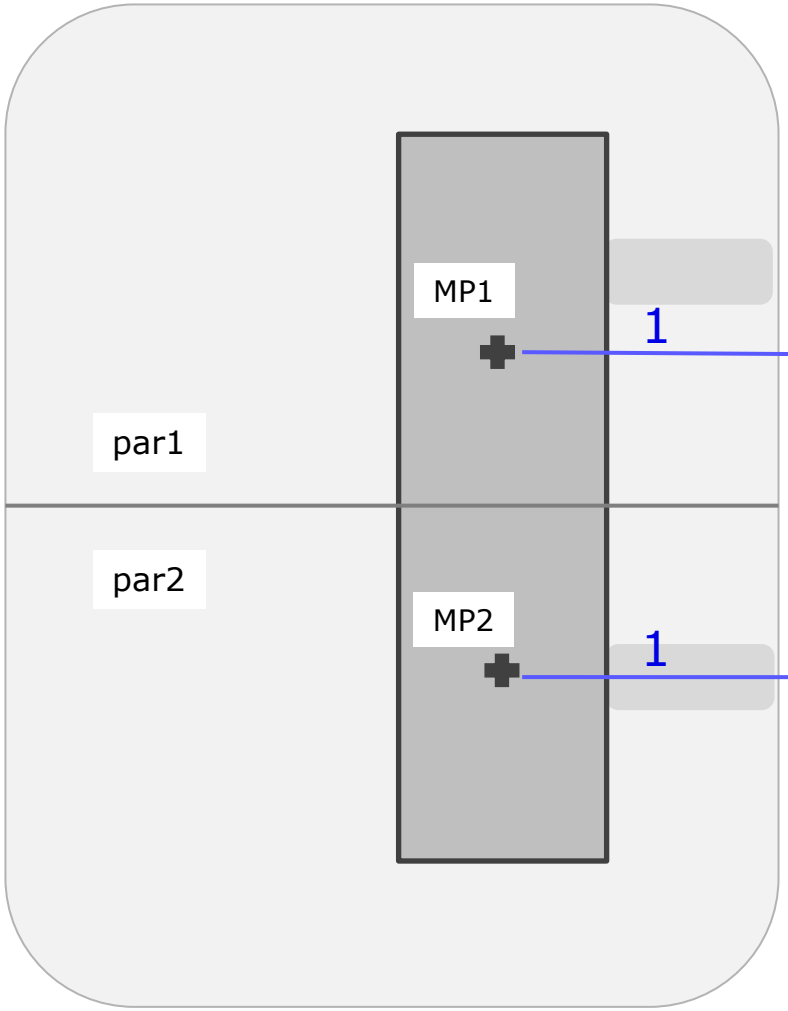
MP1-3 = 3 address multi-points
par1 = parcel LOC_ID

Master Address Database – building entry or building interior points from local source

Large commercial building with multiple numbered addresses has just one recorded by assessor (perhaps main entrance).

Other addresses appear as linear geocodes to indicated need for field verification. Address records not linked to structure will get addrpt_id for building interior points from fieldwork.

Two parcels, one building, two numbered addresses



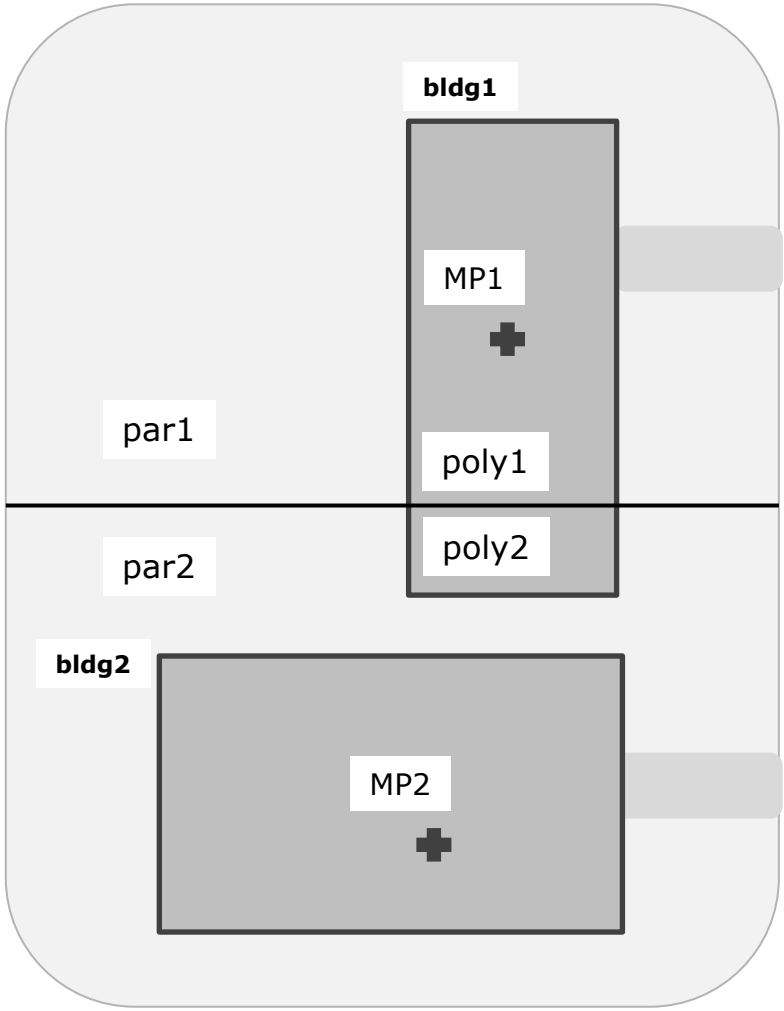
In many situations, a single structure spans multiple parcels in different ownership with different addresses assigned to each part of the structure.

LOC_ID	ADDRPT_ID	FULL_ADDR
par1	MP1	2 MARCELLUS DRIVE

LOC_ID	ADDRPT_ID	FULL_ADDR
par2	MP2	4 MARCELLUS DRIVE

MP1 & MP2 = 2 address multi-points created as centroids of building overlay with par1 and par2 polys

Two parcels split one building - when not to retain address point for both parts



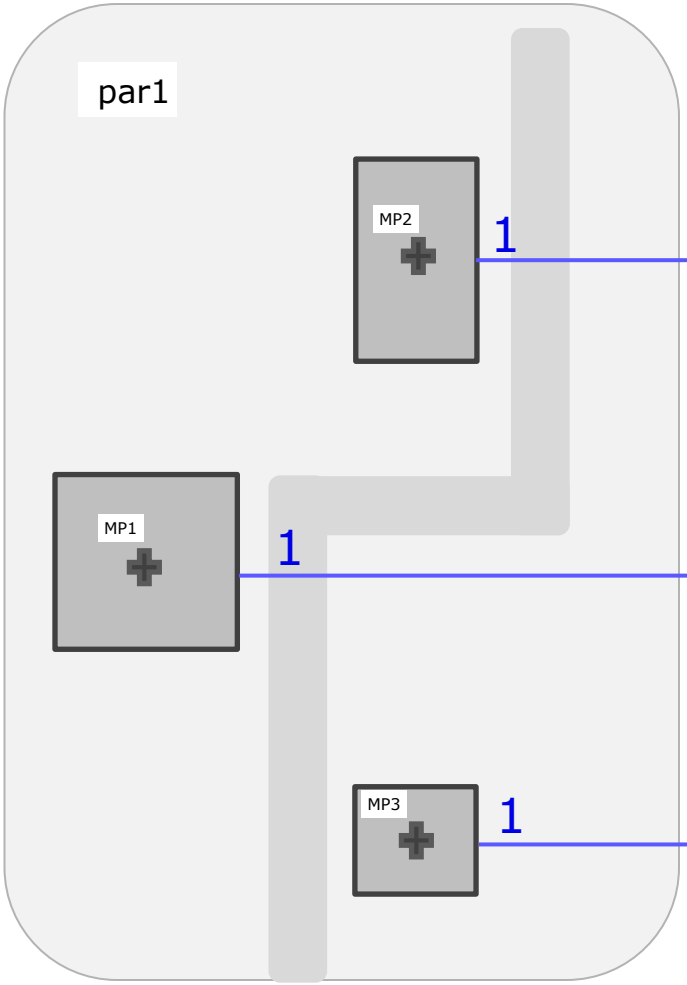
MP1 = address multi-point created as centroid of building split by parcel boundary, additional multi-point in poly2 discarded if*:*
area poly2 < 15% area bldg1
or
area poly2 < 150 s.f.
or
area bldg2 > area poly2 *and*
area poly2 < 1000 s.f. *and*
area poly2 < 50% area bldg1

but not if*:*
no bldg2 and par2 has valid address or year-built or building-value

in all cases, perform manual review if poly2 receives address point based on above conditions

Campus – a "site" with many structures, each must be named

Separate address points are created when buildings on a site have different numbered addresses or must be distinguished by name. This involves "exploding" the multi-point features.

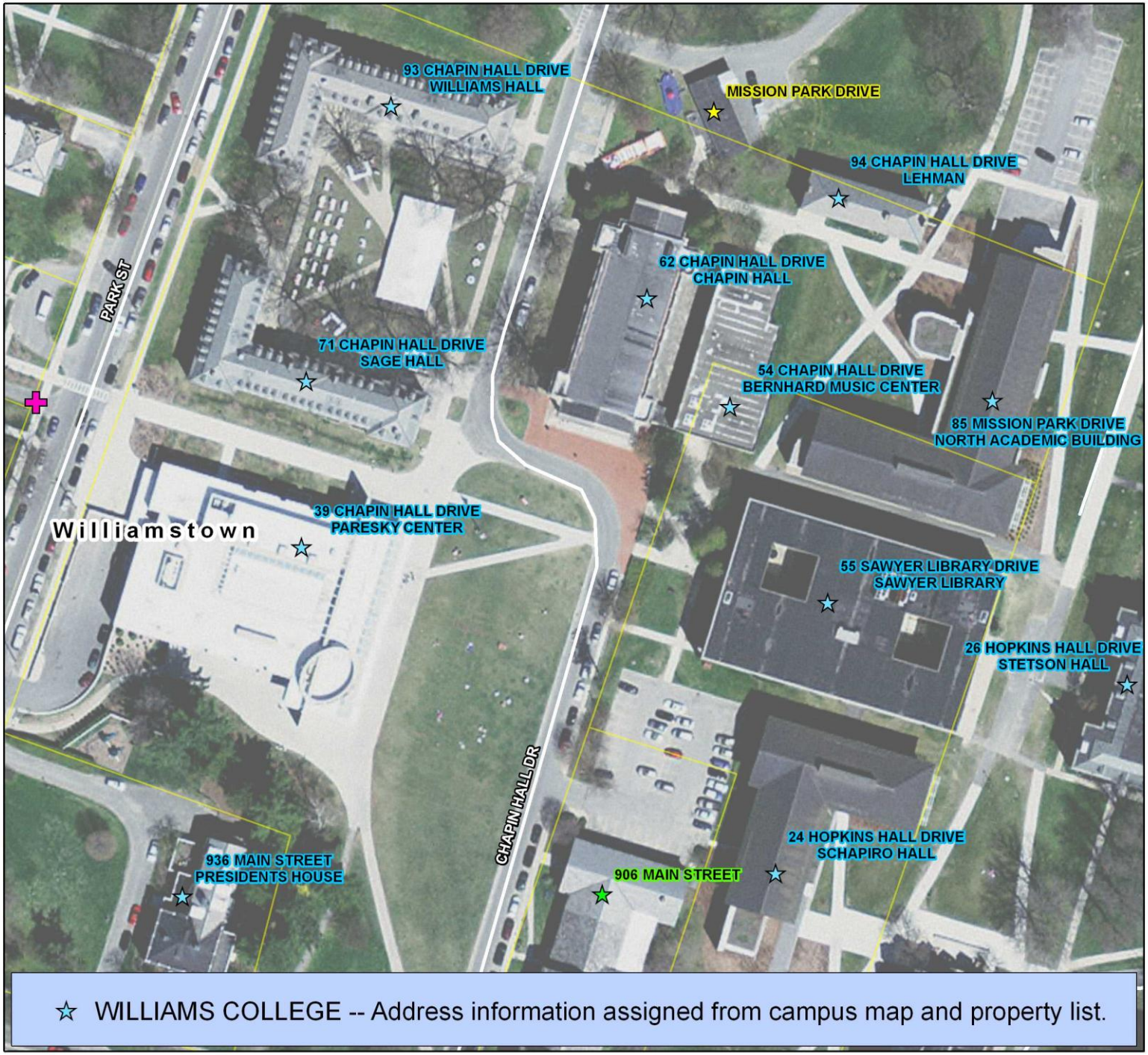


LOC_ID	ADDRPT_ID	FULL_NUM	FULL_STR	FULL_LOC
par1	MP2	100	CLARK UNIVERSITY DRIVE	BANCROFT HALL

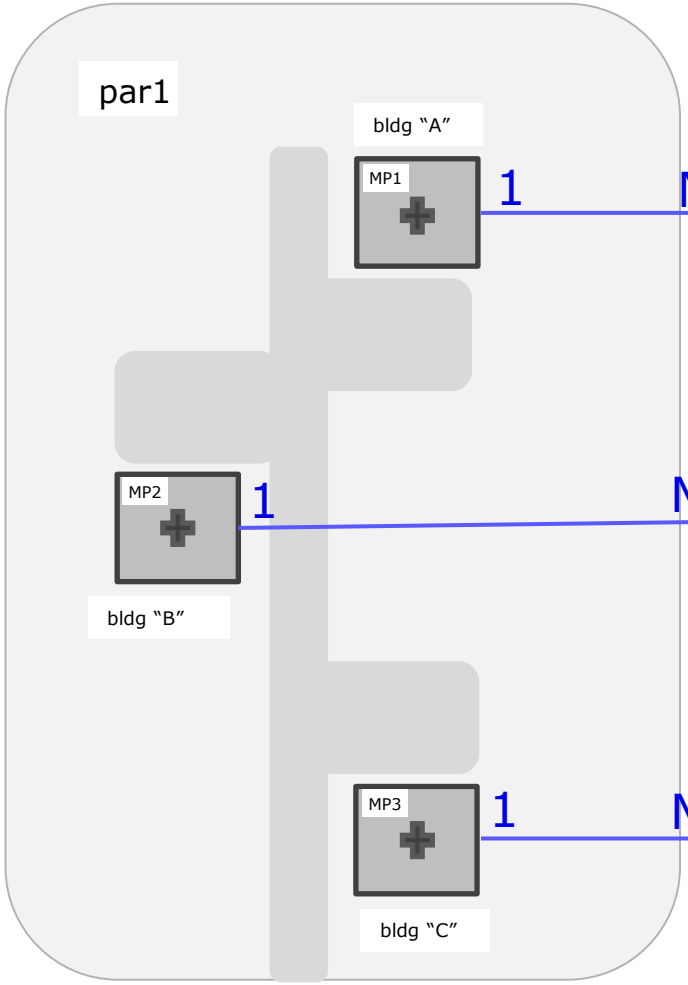
LOC_ID	ADDRPT_ID	FULL_NUM	FULL_STR	FULL_LOC
par1	MP1	100	CLARK UNIVERSITY DRIVE	MARSHALL GYM

LOC_ID	ADDRPT_ID	FULL_NUM	FULL_STR	FULL_LOC
par1	MP3	100	CLARK UNIVERSITY DRIVE	ADMISSIONS OFFICE

Trailer Park Map -- Address information assigned from trailer park map


93 CHAPIN HALL DRIVE
WILLIAMS HALL
MISSION PARK DRIVE
94 CHAPIN HALL DRIVE
LEHMAN
62 CHAPIN HALL DRIVE
CHAPIN HALL
PARK ST
71 CHAPIN HALL DRIVE
SAGE HALL
54 CHAPIN HALL DRIVE
BERNHARD MUSIC CENTER
85 MISSION PARK DRIVE
NORTH ACADEMIC BUILDING
Williamstown
39 CHAPIN HALL DRIVE
PARESKY CENTER
55 SAWYER LIBRARY DRIVE
SAWYER LIBRARY
26 HOPKINS HALL DRIVE
STETSON HALL
CHAPIN HALL DR
24 HOPKINS HALL DRIVE
SCHAPIRO HALL
936 MAIN STREET
PRESIDENTS HOUSE
906 MAIN STREET
☆ WILLIAMS COLLEGE -- Address information assigned from campus map and property list.

Condo complex – a "site" with many structures, each with multiple units



LOC_ID	ADDRPT_ID	FULL_NUM	FULL_STR	FULL_LOC	BUILDING	UNIT
par1	MP1	100	GREENWOOD DRIVE	UNIT A-1	A	1
par1	MP1	100	GREENWOOD DRIVE	UNIT A-2	A	2
par1	MP1	100	GREENWOOD DRIVE	UNIT A-3	A	3
par1	MP1	100	GREENWOOD DRIVE	UNIT A-4	A	4

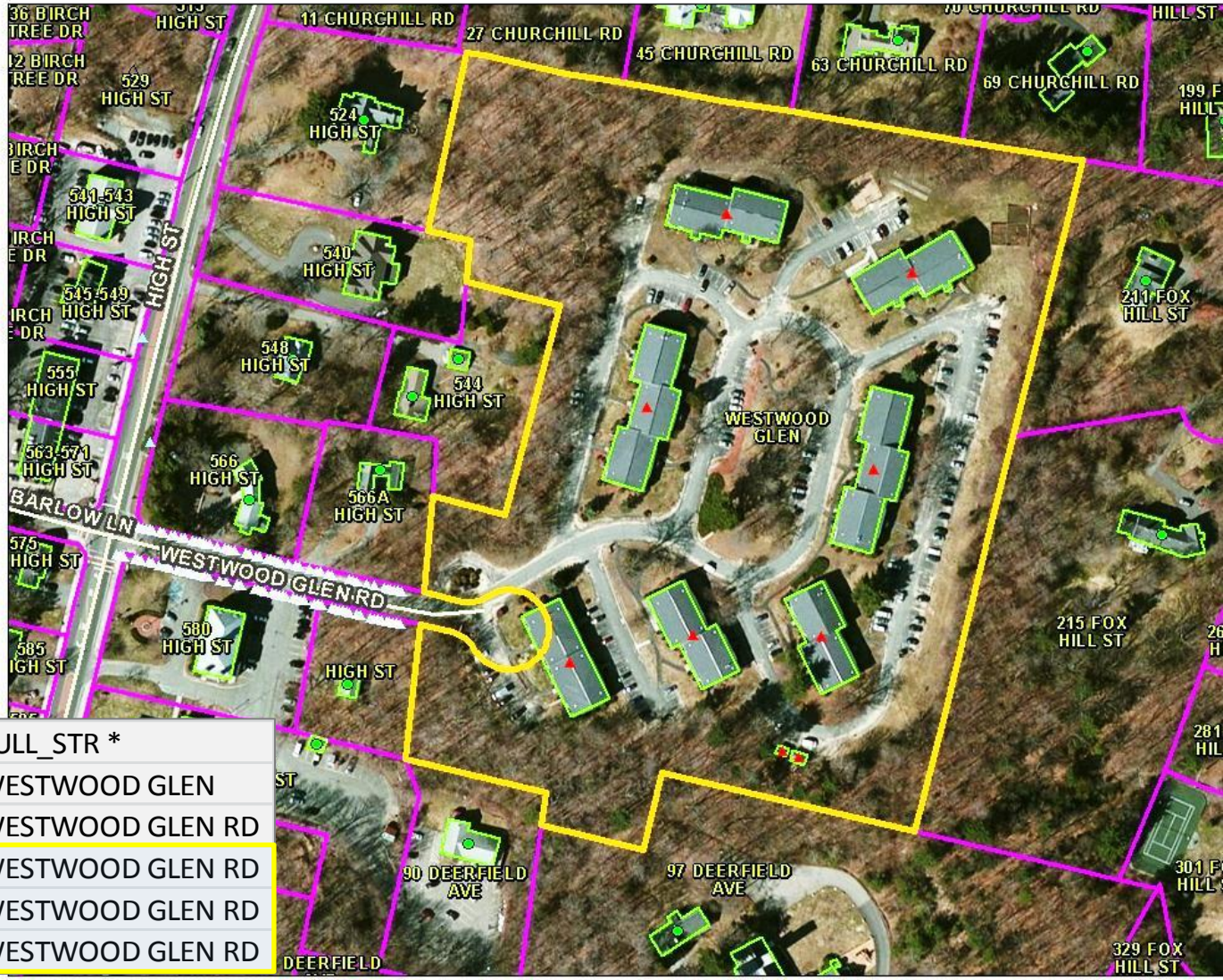
LOC_ID	ADDRPT_ID	FULL_NUM	FULL_STR	FULL_LOC	BUILDING	UNIT
par1	MP2	100	GREENWOOD DRIVE	UNIT B-1	B	1
par1	MP2	100	GREENWOOD DRIVE	UNIT B-2	B	2
par1	MP2	100	GREENWOOD DRIVE	UNIT B-3	B	3
par1	MP2	100	GREENWOOD DRIVE	UNIT B-4	B	4

LOC_ID	ADDRPT_ID	FULL_NUM	FULL_STR	FULL_LOC	BUILDING	UNIT
par1	MP3	100	GREENWOOD DRIVE	UNIT C-1	C	1
par1	MP3	100	GREENWOOD DRIVE	UNIT C-2	C	2
par1	MP3	100	GREENWOOD DRIVE	UNIT C-3	C	3
par1	MP3	100	GREENWOOD DRIVE	UNIT C-4	C	4

Master Address Database examples (designated site, before fieldwork)

"WESTWOOD GLEN" record in tax list is represented as a multi-point.

Individual address records are not linked to any point location and so appear as linear geocodes (light blue).



SOURCETYPE *	FULL_NUM *	FULL_STR *
L3	<Null>	WESTWOOD GLEN
MSAG	1-161	WESTWOOD GLEN RD
ESL	153	WESTWOOD GLEN RD
ESL	154	WESTWOOD GLEN RD
ESL	159	WESTWOOD GLEN RD

Master Address Database (after fieldwork)

After fieldwork, groups of records are associated with one or more points per building. Linear geocodes not needed.

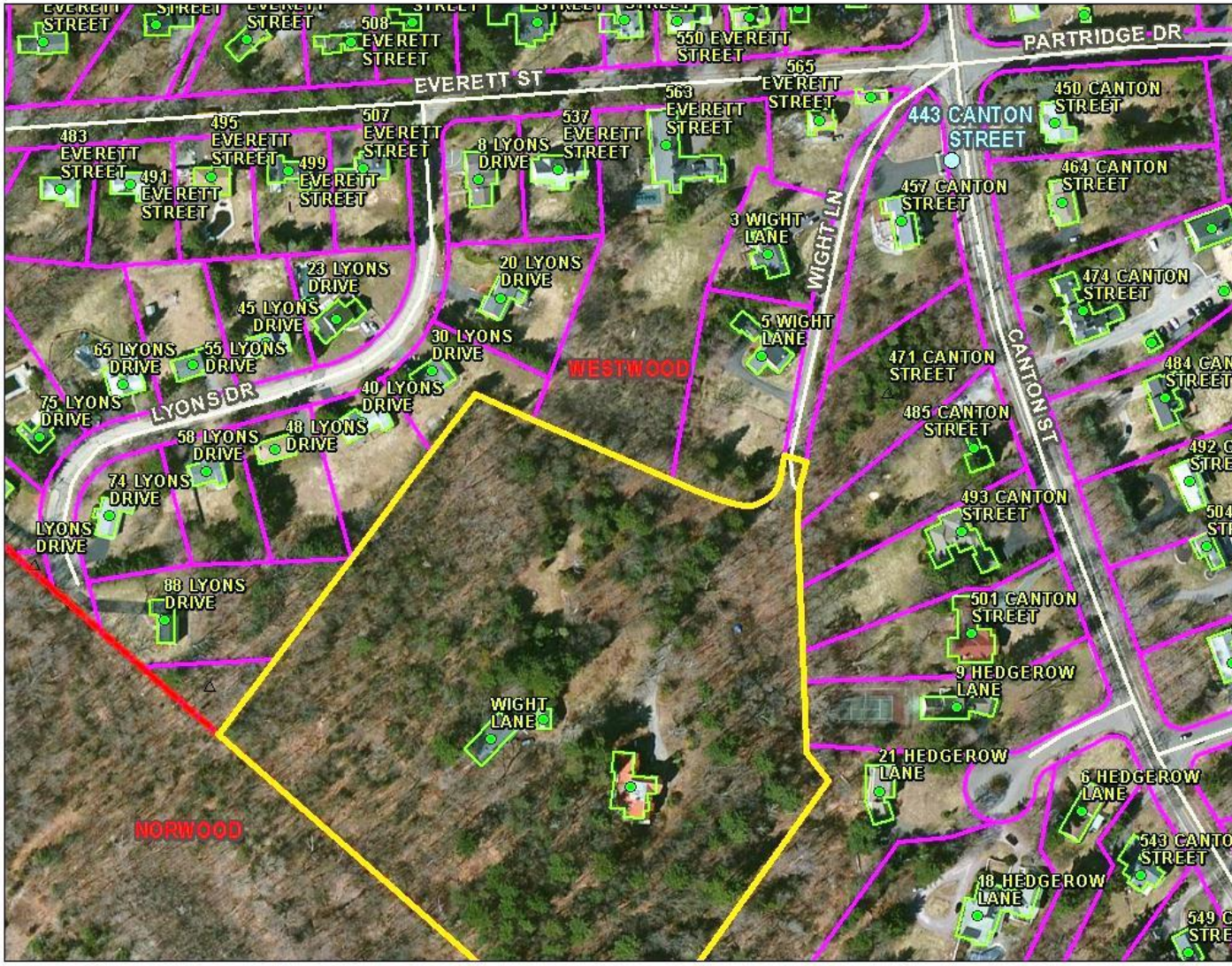
SOURCETYPE *	FULL_NUM *	FULL_STR *
L3	<Null>	WESTWOOD GLEN
MSAG	1-161	WESTWOOD GLEN RD
ESL	153	WESTWOOD GLEN RD
ESL	154	WESTWOOD GLEN RD
ESL	159	WESTWOOD GLEN RD

Addrpt_id links the records in the MAF to the address point features

Master Address Database examples – research required for some addresses

The parcel highlighted in orange has no number on Wight Lane in the assessors database. In fact, the address appears as 443 Canton Street in the ESL and other sources. Originally, Wight Lane was just a driveway for the house and not developed.

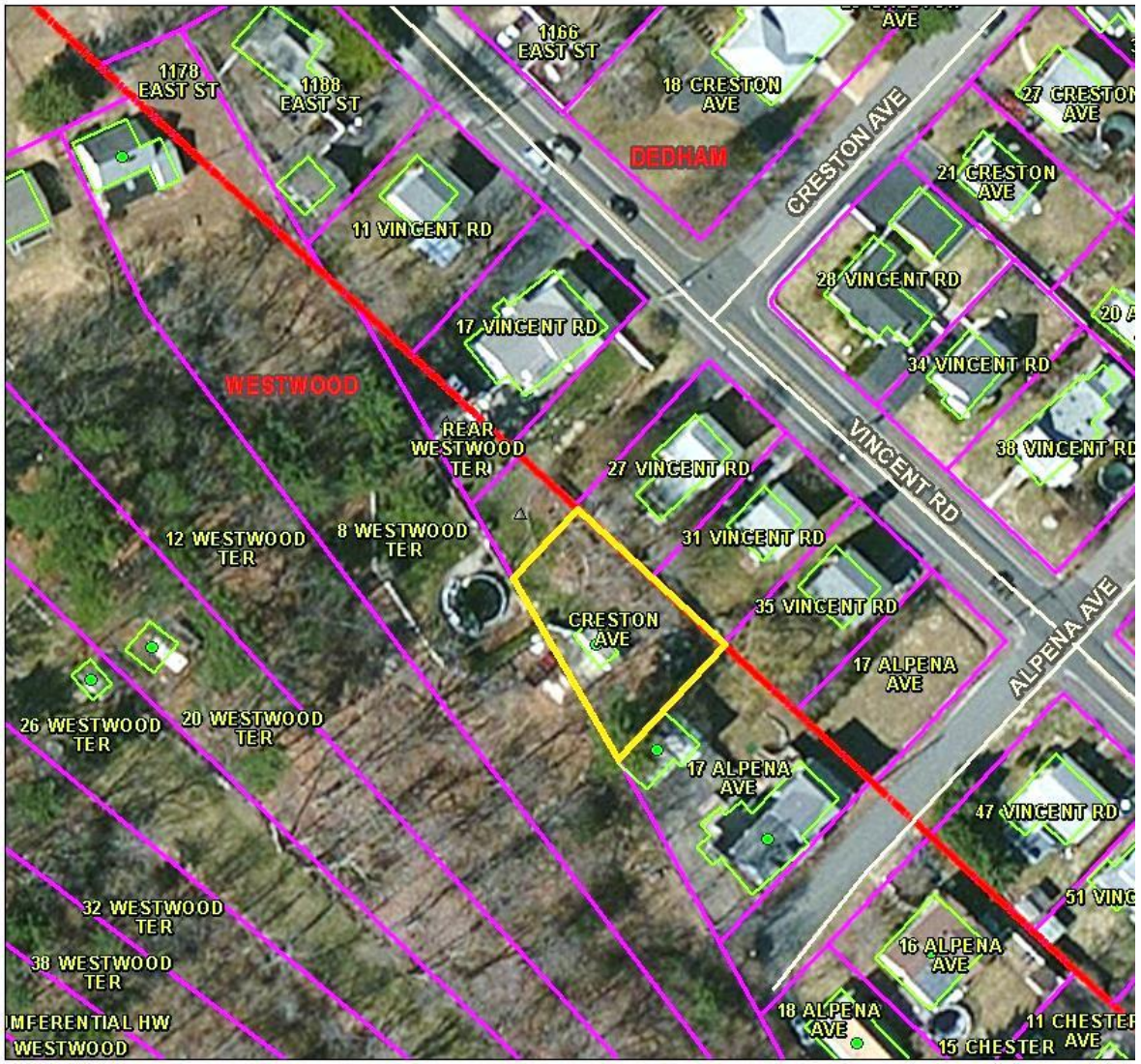
The addrpt_id for the two structures is added to the 443 Canton Street records.



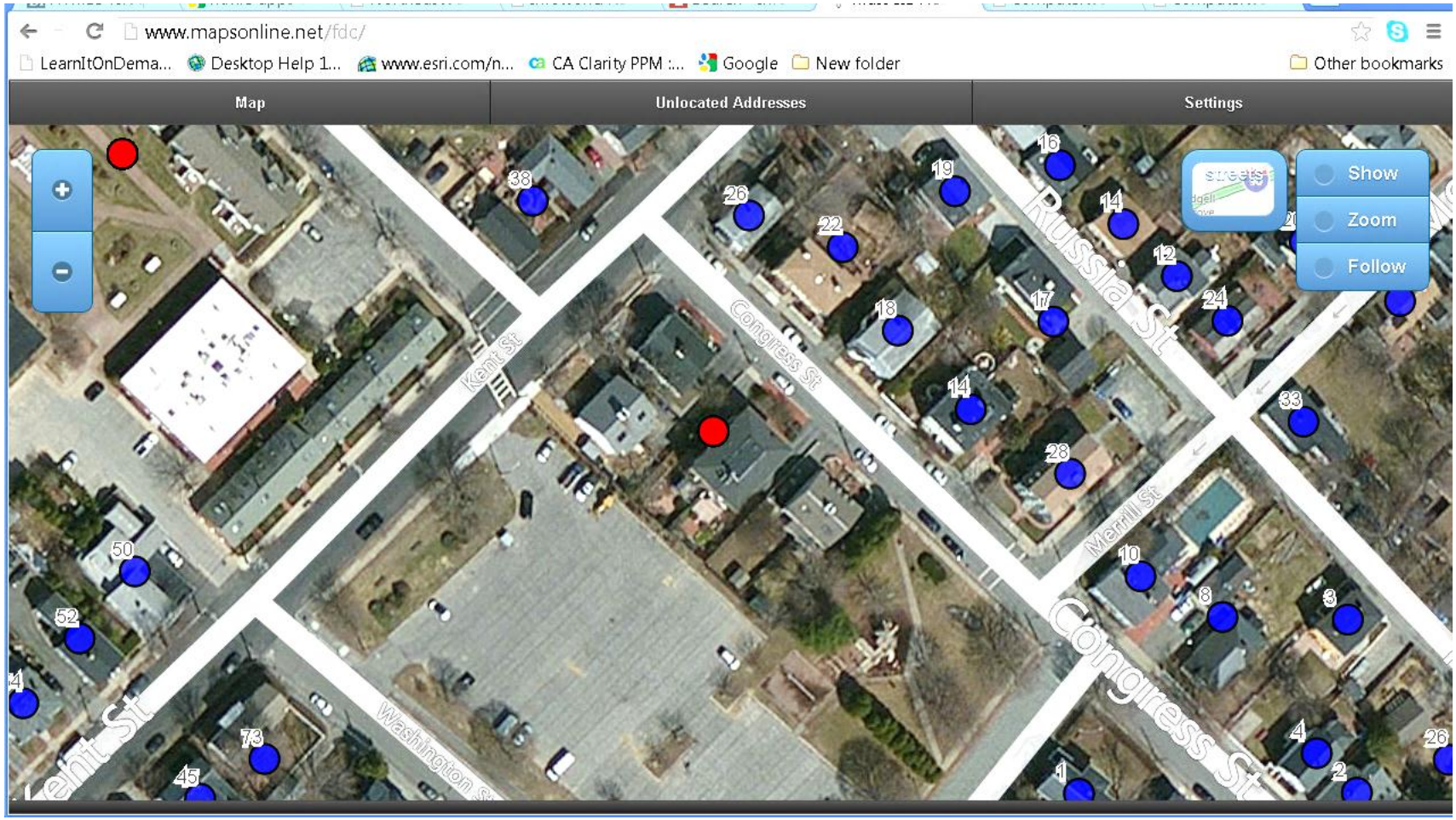
Master Address Database – research required for some addresses

The pool house and landscaping on Creston Ave parcel in Westwood (highlighted in orange) appear to be associated with 17 Vincent Road in neighboring town.

Since this parcel has a structure, we need to investigate addressing.



Tablet app to review addresses in the field



How will we find out about new addresses?

- **Right now, we get updates to the ESL and identify new and changed records, but land-lines, the source of data for the ESL, are going away**
- **we are trying to link into local workflows for address creation and maintenance**
- **RPAs did survey to identify "addressing authority" in each community**
- **Other potential sources of address data in real-time are:**
  - utilities, may capture location, limited number of sources, location will be electric drop, not always at building
  - ZIP plus four, monthly updates from PO

How will we locate new addresses?

- **In general, this will involve field work with GPS and some kind of mobile data collection device, similar to how we plan to clean up the draft point data**
- **In VT – 2 people drive around and do this work for the entire state**
- **In most states, counties maintain this information**
- **Best practice is to locate new address points inside structure outlines as they will appear on the next orthophoto, but that has practical constraints**
  - estimating exact location is hard, especially if you can't access building site
  - equipment does exist to collect distance and bearing to a target in the field along with GPS location of the observer and record that in a mobile device

What's next?

- **Version 2 of mobile app under development and will be complete by April of this year**
- **Datasets of points for field review are being prepared for each town**
  - locations needing numbered address
  - locations needing more address detail (site)
  - addresses we cannot locate at all
  - addresses we need to locate more precisely
- **We will be ready to provide data and support communities working in the field starting this spring**
- **We are merging local datasets into the statewide database where they can add value**
  - planimetrics (we will compare)
  - point datasets (ideally, conforming to our data model)

Feedback, Comments, Questions

We want to hear from you:

- **Do you have questions or concerns about this project?**
- **Are you trying to solve the same problem at the local level?**
- **What can we learn from your efforts and experience?**
- **The GIS data address location database will be an incredibly valuable resource for municipalities**
  - public safety, permitting, notifications, schools etc.

How are you currently using address data?

Most important, we want to engage you in this effort:

- **We are already working with many cities and towns to review the street map and the emergency service zones**
- **We want to work with communities to make the master address database as complete and accurate as it can be by doing field work**
- **For new addresses – send us email at Notify911Address@state.ma.us**
  - For new subdivisions we will get NAVTEQ to map the new streets and ranges
  - For all new addresses we will add that location to be field verified